PHYTOCATALYTIC AND ADSORPTIVE REMOVAL OF POLLUTANTS FROM SEWAGE TREATMENT PLANT (STP) WASTEWATER USING INTEGRATED APPROACHES PERTINENT TO DAYALBAGH REGION

Synopsis

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Submitted By

Jeetendra Singh

Under the supervision of

Dr. Rajiv Ranjan

Co-Supervisor

Dr. S.K. Soni

Supervisor

DEPARTMENT OF BOTANY, FACULTY OF SCIENCE
DAYALBAGH EDUCATIONAL INSTITUTE (DEEMED UNIVERSITY)
DAYALBAGH AGRA-5, 282005

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Introduction

Water is one among the most important substances on planet earth essential for survival of life. About 75% of the bodyweight is mostly made up of water, if there is no water there would be no life. Water covers about 71% of the earth's surface and only 2.5% of total water is fresh and drinking water (P. Rajasulochana and V. Preethy, 2016). Water scarcity is a global problem about 40% global population are affected. Freshwater is an important water source for the consumption of living organisms on the planet. Freshwater sources are limited and precious on Earth. However, due to the rapid growth of the human population, urbanization, and industrialization release enormous wastewater. Which is now significantly being used commonly for irrigation in urban and semi-urban agriculture crops. And no doubt it is very cheapest mode of irrigation, but long-term use of such water may harm our crops, soil, and human health as well. This wastewater or polluted water may sometime pollute drinking water system, hand pumps, ground water etc. Approximately 1.1 billion people are using unsafe drinking water. Worldwide, 60% of deaths from diarrhoeal illness are attributable of the unsafe water use, inadequate sanitation, and poor hygiene (Liu h, 2010). Water-borne disease is leading among that cause mortality and morbidity, 1.8 million people are killed and causing approximately 4 billion cases of illness found annually in worldwide (United Nations, (2014). The world bank Estimated that 21% of the contagious diseases, in India are water related. In India, 535,000 people are killed due to waterborne disease in 2004. About 80% of illnesses in developing countries are straight connected with contaminated Drinking water (WHO, 2019). Polluted water is directly discharged without any treatment in natural water systems, it has become a more pollutant, and the risk of that polluted water problems are extremely increasing day to day in most developing countries. Pollutants are found in wastewater originated anthropogenic sources, such as heavy metals, pesticides, waste products, pharmaceuticals, biological agents, personal care products, and cosmetics. The major chemical pollutants in wastewater are nitrogen, sulfates, and phosphorus (Rathi *et.al,* 2021).Due to progressive increase of population and industries developmental activities and expansion of per capita water consumption are turned maximum utilization of freshwater for commercial, industrial sectors and domestic, and that releases a greater volume of wastewater. In many developing countries including India, farmers are using these industrial and sewage treatment plant (STP) effluent water for irrigation purposes due to the non-availability of

alternative sources for irrigation. The effluent of sewage treatment plants is often containing high content of various macro, micronutrients, Heavy metals, and organic constituents (Sarwar *et.al,* 2017).Water pollution is significantly a challenge due to toxic and anthropogenic pollutants from increased mostly industrial and various other activities (Chaukura *et.al,* 2017). Major microbial populations (Bacteria, protozoa, viruses, fungi, and helminths, etc.) are found in wastewater. These pathogenic microorganisms in the water are spread waterborne diseases for instance diarrhea, Cholera, and typhoid. And the percolation of pollutants in groundwater resources creates challenges in water insecurity and water quality has deteriorated, it causes various health disorders (respiratory disease, cancers, and cardiovascular malfunctioning) in a living organism (Kumar, et.al., 2021). Heavy metal ions are cause biological toxicity to living organisms and can bioaccumulate in the food chain and cause several human health-related problems for instance kidney deficiency, hypertension, nervous system failure, and lung problems (Hembrom, et.al., 2020).Reuse of STP wastewater for irrigation purposes and these are reducing the amount of water that needs to be extracted from the water bodies (Toze, S., 2006). STP wastewater is a potential solution to mitigate the problem of freshwater demand for zero water discharge and avoiding the pollution burden in the receiving water bodies.

Irrigation of cultivated fields by STP wastewater and contaminated the soil. Toxic load heavy metal has made an appearance of a new threat to agriculture. The application of STP wastewater results in the reduction of crop yield and collapse of the physiochemical properties of soil (Parween, et.al.2011). Toxic elements from STP wastewater and absorbed by cultivated field crops plant. Thereafter, they are absorbed by the vegetables and field crops plants and enter the food chain then causes long-term effects on human health.The various conventional methods for the STP wastewater treatment are present but these methods are very costly and non-reasonable. The advanced integrated approaches are being overcome by the conventional methods of STP water treatment (Turovskiy; 1998). This present study is related to develop some advanced low-cost treatment methods for STP water treatment using some physical and biochemical treatment processes using different plants material and other chemical constituents. These materials have the potential for removal efficiency of targeted wastewater are contains some pollutants such as nitrogen and phosphorus from human waste, food and certain soaps and detergents pollutants and heavy metals. We have used some applications for STP water treatment

such as adsorption, phytocatalytic, filtration, absorptions, aeration, and other treatment methods.In Dayalbagh Area, we have 1600-acre land and majority of water to irrigate such a large land is STP water which is not suitable for even irrigation as it consists of variety of impurities. The current research work will be focused on integrated approaches to treat STP water and make it suitable for at least irrigation purposes.There are various industrial areas within 30 km of Agra city embrace oil mills, battery industries, electroplating, textile paper, and leather industries. The common effluent treatment plant (CETP) is established in industrial areas, it is not able to treat the effluent adequately due to its complex nature and lack of adequate facilities in each industry's facilities. The CETP is released directly in Sewage Water. After STP treatment these water farmers have used this water for crop irrigation. And that is nearly risk of soil and vegetables. These cultivated food crops and vegetables are generating a long-term effect on the health of local living peoples.

Review of literature

- According to **Shekhar *et.al,* (2004)** Contamination of sewage and industrial effluents by heavy metals. The human risk was assessed in people exposed to pollution by heavy metal concentration is found in human blood and urine. These findings that the high amounts of Pb, Zn, Ni, and Cr are compared to permissible limits, attributable to the consumption of contaminated foods.
- **Sung Ra, *et.al,* (2008)** was studied that the *Daphnia Magna* are assed the compare toxicities in the whole effluent toxicity (WET) test. The experimental work that is using chemical analysis and bioassay on heavy metals was found to be major compounds are cause the toxic effect on *Daphnia Magna.* In the WET samples by using *Daphnia Magna* toxicities are observed in the effluent sample is 34%.
- **Singh, A., & Agrawal, M. (2012)** studied that the long-term use of wastewater on soil and that are modified the physiochemical and biological properties of soil. Metal concentration in the soil is increased due to being irrigated by wastewater. Pollution index values are showed that the concentration of heavy metals is causes metal toxicity in soil, but Cd has the potential to cause an adverse effect given a higher index. Metal toxicity in natural field conditions having long-term practices of using wastewater irrigation and that metal toxicity is the transfer of the food chain. Heavy metals contamination is having risks on human health.

- **Azmi and Low, (2016)** are investigating the membrane-based colorimetric sensor for the detection of heavy metals in ground and STP wastewater. These sensors are made up of covalent immobilization of dithizone (DTZ) on cellulose acetate membrane. These membrane-based sensors can produce a distinctive color change in the presence of heavy metals. Detection and observation of the heavy metals by naked eyes and combination of Densitometer.
- **Rajasulochana and Preethy, (2016)** are present a review on the biological treatment methods by using the algae. Algae are efficient for reducing toxic components in wastewater. There are no unique methods for a treat most compounds in a single step. Potential implementation strategies, such as sorption isotherms, ion-exchange constants, and algal biosorption are found to be important steps for wastewater treatment. Algae are potential for the reduction of BOD, N, and P content, inhibition of coliform bacteria, and removal of heavy metals. After the treatment process biomass is used for further use like Biofuels, animal feed in aquaculture, and production of such chemicals.
- **Kandasamy *et.al,* (2016)** are studied that the use of TiO2 catalyst and sonocatalytic reactor are efficient for the removal of BOD, COD, and TDS were 87.35 %, 89.53 %, 92.63 % are removed respectively. Sonocatalytic reactors are efficient for the treatment of tannery effluent. The present predicted and adjusted values (R2) were founded to be 0.9484, 0.9926 percentage for BOD, 0.9956, 0.9980, 0.9954 percentage for COD and 0.9980, 0.9954 percentage for TDS removal respectively.
- **Chakraborty *et.al,* (2016)** were studied using disinfections from water in a batch reactor using chloridized silver surfaces. The use of chloridized silver surface is an effective technique for disinfection of water and that is demonstrated the bactericidal effect of chloridized silver wires. The infection correlated with the release of chlorized silver ions from the surfaces and that are affected by changes in water quality and other constituents.
- **Rajasulochana and Preethy, (2016)** were reviewed that the biological treatments have gained popularity for the removal of toxic and harmful constituents from wastewater. By using different techniques biological treatments are potential for wastewater treatment.
- **El-Shafey *et.al,* (2016)** was prepared a dehydrated carbon (DC) from date palm leaflets by using H_2SO_4 dehydration at 200^oC. DC surfaces are functionalized by using the ethylene diamine

coupling and that is formed a basic dehydrated carbon (BDC). DC acts as a cation exchanger because the domination of the carboxylic group is present on its surface. BDC is showed better performance for the removal of Cu^{2+} and SO_4^{2-} than DC. Mostly at high pH BDC are acting as a chelating ion exchanger with the presence of the amide and amine group are present on its surface. Both carbons are showed good efficiency for the mass removal of Cu^{2+} and SO_4^{2-}.

- **Banu, H. T., & Meenakshi, S. (2017)** was demonstrated that the use of melamine-formaldehyde resin (MFQ) for the removal of nitrate from wastewater. MFQ is a great sorbent for the removal of nitrate. The sorption capacity of MFQ is quite useful compared with other suggested sorbents for nitrate removal from an aqueous solution.
- **Chaukura *et.al,* (2017)** purposed that the number of different porous materials are potentially used for the removal of pollutants from aqueous solution. Use of waste polystyrene as a material for simultaneously cleaning process.
- **Oladipo *et.al,* (2017)** studied that the MgO-NPs are synthesized from papaya leaf extract at 500oC. these materials are applied for the reduction of BOD and COD from tannery wastewater. After applied MgO-NPs are efficiently reduced the COD and BOD percentage like-2725.9mg/L to 126.5 mg/L and 1899.5 mg/L to 104.5 mg/L respectively within the first 120 min. that are subjected for the several cycles and use-reuse without loss of capacity.

- **Chonde, S., & Raut, P. (2017)** were demonstrated that the use of plant-based coagulant is more effective in wastewater treatment. *Moringa oleifera* seeds can be used as a natural coagulant and have a similar effect as the Alum. *M. oleifera* shows a maximum decrease in BOD, COD, and hardness of wastewater.
- **Manyuchi *et.al,* (2018)** demonstrated that Biochar is a potential source for sewage wastewater treatment. The physiological parameters of sewage wastewater were measured before and after filtration of biochar. In presence of a biochar reduction rate more than 75% was observed for the total nitrogen, BOD, COD, total solids, EC, and total phosphate. The pH is changed after apply biochar. Biochar is effectively clean wastewater through adsorption and bioaccumulation process.

- **Ahmad Hussaini jagaba, *et.al,* (2018)** studied the coagulation-flocculation method was used to determine the effectiveness of alum and other combinations of alum with ferric chloride, zeolite, chitosan, and neem plant. All combinations are effective for pollutant removal, but color and Cd are not effectively removed. With combinations, chitosan is effective for high color and Cd removal as 96.44 %. While the use of alum alone removal of Cd is 95.75%.
- **Shuang *et.al,* (2019)** study on the activated carbon application in wastewater treatment. Activated carbon is a good non-polar adsorbant and that represents good performance in wastewater treatment. Activated carbon are adsorbing various pollutants in wastewater, because of the huge specific micropore and surface area. That is used either alone or in combination with other wastewater treatment techniques.
- **Dan Yu *et.al,* (2020)** studied that are develop of low-cost and effective techniques for the treatment of wastewater. That is prepared a novel and scalable MXene/CNTs/Cotton fabric-based solar steam system and it is used for the treatment of textile wastewater treatment. Cotton fabric materials are satisfactory stability and durability for wastewater treatment. The concentration of organic and inorganic pollutants had dramatically reduced during the evaporation process. And that cotton-based treatment is potential for textile wastewater purification.
- According to **Kristanti *et.al,* (2021)**, Groundwater serves as the water recharge surface are provides clean water for domestic, industrial, and agricultural usages for human life. Rapid growth urbanization and industrialization as resulted from the water bodies are contaminated. Contamination in groundwater by pesticides, heavy metals, cosmetics, pharmaceuticals, waste by-products, and biological agents. Rhizo-filtration is an environmentally friendly alternative source for the mitigate groundwater pollution.
- **Geeta Saini, *et.al,* (2021)** developed some simple and low-cost method for small scale wastewater treatment plant for the purification of wastewater generated by canteens, household, some laboratories, and educational institutes. In this paper that are explored the process of phytoremediation by plants (*Typha latifolia L.* and *Canna indica*) for the removal of metal ions and phosphate ions from discharged wastewater. After phytoremediation was further purified with the use of sand filter. Various parameters are analysed before and after filtration were analyzed and

observed that there are slightly significant for the reduction of hardness, COD, and turbidity. And after treatment treated water can be reused for various agriculture and household activities.

Objectives of the study:

- Collection and Analysis of water sample obtained from STP Dayalbagh region.
- Treatment of STP wastewater using adsorptive efficiency of different material.
- Treatment of STP wastewater using Phyto catalytic efficiency of different plant material.
- Developing an integrated approach for bioremediation of STP wastewater.

Materials and Methods

1. Collection and analysis of STP water samples.

1.1 Collection of STP wastewater sample

STP water would be collected in a well sterile bottle from Dayalbagh STP plant.

1.2 **Analysis of STP Water**

Analysis of STP water sample will be carried out by using Standard Protocol. "Standard methods for the examination of water and wastewater", 23rd Edition (Baird R B, 2017) and APHA (1995), parameters are as follow-

Table-1 Parameters for analysis

Physiochemical Parameters	Biochemical
pH	Proteins
Temperature	Lipids
Biological Oxygen Demand	Phosphorus
Chemical Oxygen Demand	Oil & Greases
Dissolved Oxygen	Heavy Metals (Pb, Ni, Sn, Cr, As, Cd)
Hardness	Chloride
Alkalinity	Ammonia
Salinity	Nitrogen
TDS (Total Dissolved solids)	Phosphate
Turbidity	Sulphate
Electrical conductivity	Calcium
Detergent and surfactant	Potassium
Free CO_2	Fluoride
	Boron
	Sodium Iodine

2. **Treatment of STP wastewater using adsorptive efficiency of different material**

Different biological, chemical and physical materials will be used to check the efficiency of these materials in context of removal of pollutants from STP wastewater. The following biological, chemical, and physical material will be used to check their adsorptive efficiency to remove pollutants from STP wastewater.

Physical Material

A. Sand layers (Different particle size)

B. Zeolites

C. Cotton/tailor waste

D. Pottery waste

E. Aeration

Chemical Material

A. Alum and Sodium bi carbonate

B. Charcoal

C. Biochar

D. Activated Carbon

E. Lime

Biological Material

A. Rice Husk

3. **Treatment of STP wastewater using Phyto catalytic efficiency of different plant material.**

Some selected plant material will be used to evaluate the Phyto catalytic efficiency for treatment of STP wastewater. Leaves and seeds of selected plants will be used for this experimentation. Leaves powder and Leaves powder bio beads both will be used. The leaves of *Azadirachta indica*, *Moringa oliefera*, *Lemon grass*, *Ocimum tenuiflorum*, *Coriandrum sativum*, *Phyllanthus emblica* (fruit), *Camellia sinensis* and seeds of *Moringa oliefera* will be used.

4. **Developing an integrated approach for Bioremediation of STP wastewater**

For developing an integrated approach for bioremediation of STP water, the most effective material among all the Biological, chemical, and physical materials will be collectively used to treat STP wastewater.

Significance of the present Study

Sewage treatment water is big source of wastewater. In recent time treatment of domestic wastewater is being carried out but detailed investigation is still under process. wastewater treatment is not done effectively. In Dayalbagh region major source of crop irrigation such a large land is STP water. which is not suitable for even irrigation as it consists of variety of impurities. The present research work is focused on the developing integrated approaches to treat STP wastewater and make it suitable for irrigation and other purposes.

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